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Preliminary Observations on Effects of Pesticides Carbaryl, Naphthol, and Chlorpyrifos on Planulae of the Hermatypic Coral *Pocillopora damicornis*[1]

ROBERTO ACEVEDO[2]

ABSTRACT: Planulae larvae of the reef coral *Pocillopora damicornis* were exposed to three pesticides in concentrations ranging from 0.01 to 100 ppm. Actively swimming planulae were held in test solutions for 96 hr, after which viability was determined. Carbaryl and 1-naphthol in concentrations up to 10 ppm had no effect on the planulae after 96 hr. Chlorpyrifos at levels of 1 ppm and higher resulted in mortality in 50 to 100% of the trials.

TODAY, AN ESTIMATED 5% of all crops are grown naturally or with reduced levels of synthetics. Recently, at least 26 pesticides have been canceled or suspended by the Environmental Protection Agency (EPA). These have been demonstrated to be hazardous to the environment in one way or another. More research needs to be done to detect the effects of these chemicals on the enviroment before they finally degrade into inert substances. Fields heavily dosed with fertilizers, pesticides, and herbicides have been defined by the EPA as the largest source of surface water pollution (U.S. Environmental Protection Agency 1988). Once these bodies of water are contaminated, these substances are just one step away from reaching the coastal areas and embayments.

Very little work has been done on the effects of pesticides on corals and coral planulae. Some pesticides are biocidal substances whose effects on marine life are completely unknown. Because corals reproduce mainly during certain periods throughout the year (some only once a year), it is important that environmental conditions are within their tolerance limits.

The purpose of this study was to investigate the effects of three of the most widely used pesticides on the planula of the hermatypic coral *Pocillopora damicornis*. The chemicals used in this study were as follows: (1) Carbaryl, also known as Sevin®, a contact- and stomach-action insecticide with mild cholinesterase-inhibiting properties. Cholinesterase-inhibiting substances affect the nervous system of organisms, paralyzing them partially or totally. Carbaryl appears to hydrolyze rapidly in seawater, with a half-life of 24 hr at pH 7.9 or 23 hr at pH 8.2 (K. Armbrust, pers. comm.). (2) 1-naphthol, which is formed as the insecticide carbaryl degrades. It has action properties similar to those of carbaryl but is much more stable and was shown not to degrade in a period of 36 hr (K. Armbrust, pers. comm.). (3) Chlorpyrifos (Dursban®), which is a nonsystemic insecticide with contact, stomach, and respiratory action. It is a strong cholinesterase inhibitor.

MATERIALS AND METHODS

Pocillopora damicornis planulae were collected from Kaneohe Bay, Oahu (Hawaii Institute of Marine Biology) 1–4 days after full moon in July 1989, and maintained alive for 2 days before treatment in 200-ml vials with running seawater at ambient temperature (25–27°C). Only planulae observed to be actively swimming were used in the experimental procedures.

Seawater containing concentrations of 0.01, 0.1, 1, 10, and 100 ppm of carbaryl, 1-naphthol, and chlorpyrifos were prepared

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[2] Department of Marine Sciences, University of Puerto Rico, P. O. Box 5000, Mayaguez, Puerto Rico 00708.

with high purity standards donated by Dr. Carl Miles of the University of Hawaii, and purity was verified by high-performance liquid chromatography (HPLC) by Mr. Kevin Armbrust. Solutions were prepared starting from a stock solution with a concentration of 1 mg/ml in MeOH. For a 0.01-ppm solution 1 μl of stock solution was added to 100 ml of seawater plus 1 ml MeOH. Other concentrations were prepared proportionally. Actively swimming planulae were transferred from holding tanks to treatment vials by suctioning them with a Pasteur pipette and releasing them in the treatment vials. Every 24 hr new solutions were prepared and planulae transferred to maintain proper pesticide concentrations throughout the experiment.

Three replicates of each treatment were prepared, each containing 10 *P. damicornis* planulae, and observed for a period of 96 hr in the shade. Planulae that stopped swimming even after prodding with a small stream of seawater were considered dead for the purpose of this study. Planulae that did not swim were transferred to running seawater holding tanks and observed for a period of 48 hr before removing them permanently. The number of swimming and nonswimming planulae was counted under magnification every 6 hr for a period of 96 hr after the treatment started.

RESULTS AND DISCUSSION

Carbaryl in concentrations of 0.01, 0.1, 1, and 10 ppm had no noticeable adverse effects on *P. damicornis* planulae for as long as the experiment lasted. All planulae were swimming normally for up to 96 hr after exposure to the chemicals. Concentrations of 100 ppm killed 70 to 90% of planulae in all three replicates within the first 12 hr of the experiment.

1-naphthol in concentrations of 0.01, 0.1, 1, and 10 ppm likewise had no noticeable adverse effects on *P. damicornis* planulae. Concentrations of 100 ppm killed 100% of them in all replicates.

Chlorpyrifos in concentrations of 0.01 ppm had no noticeable adverse effects on the planulae. Concentrations of 0.1 ppm slowed the swimming motion considerably in all three replicates, and concentrations of 1 ppm killed 50 to 100% of the planulae within 24 hr, accompanied by a decrease in the speed of motion for the ones that were still alive. Concentrations of 10 ppm killed all planulae within the first 12 hr of experimentation. No other experiments were done with higher concentrations of chlorpyrifos (Table 1).

Although *P. damicornis* planulae showed resistance to high concentrations of carbaryl and 1-naphthol, these substances killed 70–100% of planulae at concentrations of 100 ppm. Concentrations of 100 ppm are unlikely to occur, but if the pesticide was heavily used in nearshore areas and a short but strong rain event occurred over the area, elevated amounts might reach the coastal area and fringing reefs before degradation to less toxic substances could occur.

Chlorpyrifos was found to have the strongest adverse effects on coral planulae. Within 24 hr, concentrations as low as 1 ppm caused up to 50% of planulae to die, and concentrations of 0.1 ppm slowed down their motion.

More work is needed to determine the

TABLE 1

PESTICIDE EFFECTS ON *Pocillopora damicornis* PLANULAE (AFTER 24 HR OF TREATMENT)

	REPLICATES		
	1 (n = 10)	2 (n = 10)	3 (n = 10)
Carbaryl			
0.01 ppm	0	0	0
0.1 ppm	0	0	0
1 ppm	0	0	0
10 ppm	1	0	1
100 ppm	7	10	10
Chlorpyrifos			
0.01 ppm	0	0	0
0.1 ppm	0	0	0
1 ppm	5	10	6
1-naphthol			
0.01 ppm	0	0	0
0.1 ppm	0	0	0
1 ppm	1	0	1
10 ppm	5	2	3
100 ppm	9	10	9

effects of other commonly used insecticides and chemicals that may be reaching nearshore and coastal areas.

LITERATURE CITED

U.S. ENVIRONMENTAL PROTECTION AGENCY. 1988. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to marine and estuarine organisms. Publication EPA-600/4-87/028. EPA Office of Research and Development, Cincinnati, Ohio.